

T. A. EDISON.
 FILAMENT FOR INCANDESCENT ELECTRIC LAMPS.
 APPLICATION FILED MAY 31, 1907.

1,163,329.

Patented Dec. 7, 1915.

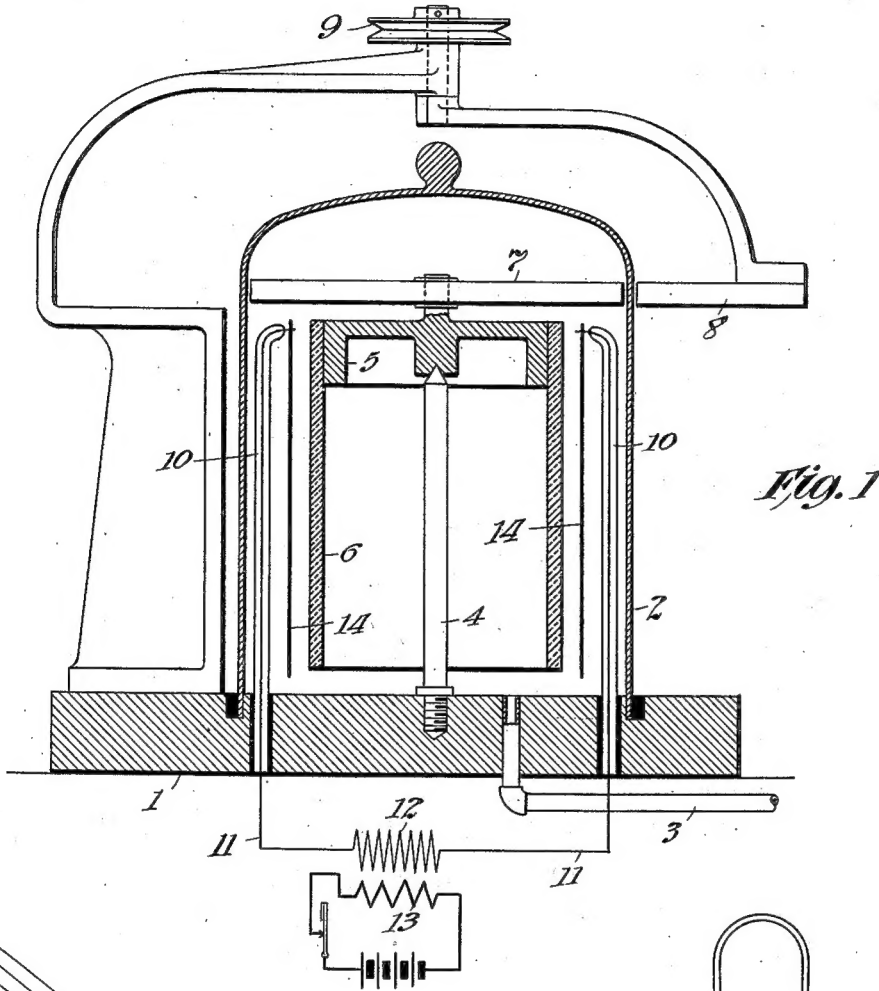


Fig. 1

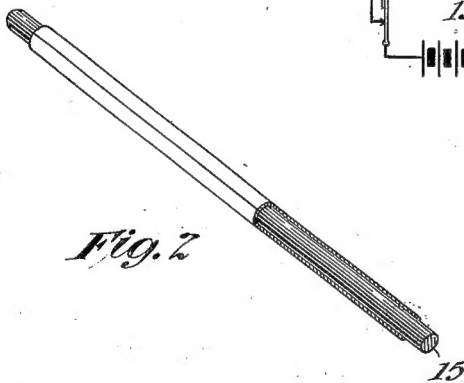


Fig. 2

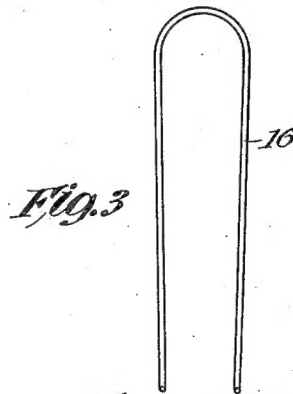


Fig. 3

Witnesses:
 Frank O. Lewis
 Anna R. Kellum

Inventor:
 Thomas A. Edison
 by Frank L. Spear
 Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, ORANGE, NEW JERSEY, ASSIGNOR TO
GENERAL ELECTRIC COMPANY, OF SCHENECTADY, NEW YORK, A CORPORATION
OF NEW YORK.

FILAMENT FOR INCANDESCENT ELECTRIC LAMPS.

1,163,329.

Specification of Letters Patent.

Patented Dec. 7, 1915.

Application filed May 31, 1907. Serial No. 376,619.

To all whom it may concern:

Be it known that I, THOMAS ALVA EDISON, a citizen of the United States, residing at Lewellyn Park, Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Filaments for Incandescent Electric Lamps, of which the following is a description.

My invention relates to improvements in filaments for incandescent electric lamps, and process of making the same, and my object is to produce a filament of an extremely refractory metal, such as tungsten or tantalum, of great homogeneity and of such extreme fineness that a relatively great resistance can be secured, whereby lamps of high voltage and low candle-power can be made.

The invention relates particularly to an incandescent electric lamp filament made of an extremely refractory metal, like tungsten or tantalum, resulting from the deposition of the metal electrically *in vacuo*.

In Letters Patent of the United States, No. 526,147, No. 713,863, and No. 767,216, and dated respectively September 18th, 1894, November 18th, 1902, and August 9th, 1904, I illustrate an improved process for plating a metal *in vacuo* upon a suitable receiving surface, whereby films of excessive thinness can be obtained. I have used this process commercially for forming a preliminary conducting coating on master phonographic records preparatory to electroplating the same in order to make molds from which duplicate copies of said masters may be obtained, and in the phonographic art I have been enabled to thus plate a perfectly coherent and homogeneous film upon a master record of such thinness as not to appreciably affect the extremely shallow record groove, the maximum depth of which is somewhat less than one one-thousandth of an inch. By my present invention I am able to produce electric lamp filaments from metallic tungsten and tantalum or other refractory metal, by a suitable modification of the process disclosed in said patents, although variations in said process may be adopted as will be apparent to those skilled in the art.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming part of this specification and in which—

Figure 1, is a diagrammatic view of a suitable apparatus on which to deposit a film of the desired refractory metal which is to be subsequently formed into strips from which the filaments may be made. Fig. 2, a perspective view partly in section, illustrating the method of manufacturing tubular filaments of refractory metal by my present process, and Fig. 3, a corresponding view illustrating the completed filament.

Referring to Fig. 1, I illustrate a base 1, carrying a suitable jar or globe 2, so as to constitute a vacuum chamber from which the air is exhausted through a pipe 3. Mounted in the vacuum chamber is a support 4, on which is rotatably mounted a suitable mandrel 5, carrying the cylindrical receiving surface 6, which may be made of glass or of a suitable wax-like material. The mandrel 5 carries the bar magnet 7, and located outside of the globe is a magnet 8 rotated by suitable power connections engaging the pulley 9, so that by turning the magnet 8, the mandrel 5 and the receiving surface within the conducting chamber will be properly rotated. The glass arms are located within the vacuum chamber and contain conductors 11 in circuit with the secondary 12 of a suitable induction coil. The primary circuit 13 of this coil is supplied with an alternating or pulsating current from any suitable source. Suspended from the free ends of the arms 10 and in circuit with the conductors 11 are electrodes 14, formed of the desired refractory metal. For example, in making these electrodes of tungsten they may be made by subjecting pure metallic tungsten in the form of powder to a sufficiently heavy compression as to effect the desired cohesion of the particles. For the manufacture of electrodes of other refractory metals, the same procedure may be followed. By making use of metallic electrodes as explained, within the vacuum chamber containing a rarefied or attenuated atmosphere, from which oxygen has been

excluded and by slowly rotating the receiving surface 6 between them, the passage of the high tension alternating current between the electrodes will result in the vaporization of the metal which will be slowly deposited on the receiving surface to gradually build up a film thereon of remarkable homogeneity and cohesiveness.

When the film has attained the desired thickness it may be removed from the receiving surface, especially when the latter is glass, by stripping it off, or by dissolving the receiving surface when the latter is of some soluble material, like wax. The sheet thus obtained is then cut into strips of the proper width and bent into the form of filaments for use in incandescent electric lamps. If desired the strips, after being severed from the sheet, may be rolled over a suitable mandrel 15 made of a soft metal or wax and then bent into horseshoe shape, after which the mandrel or core will be removed by melting or by dissolving it in a suitable solvent, leaving, as the final product, a tubular filament 16, as shown in Fig. 3. The bending of the filaments may be readily effected by heating the metal to about 700° F. at which temperature metallic tungsten is malleable. Or, if desired, a number of forms or mandrels 15 may themselves constitute a receiving surface on which the metallic deposit is made so as to result in the production of hollow seamless filaments, as will be understood.

By the process which I have described, perfectly homogeneous filaments can be obtained of remarkably small cross sectional area, whereby the manufacture of lamps of high voltage and low candle power is permitted. Obviously, such a homogeneity cannot be obtained where the metallic powder is mixed with a suitable binder, as is common.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is as follows:—

1. The process of forming a film for an incandescent lamp filament or filaments, which consists in vaporizing tungsten by an electric discharge *in vacuo*, and depositing the same on a surface in the path of the discharge, substantially as set forth.

2. The process of forming a film for an incandescent lamp filament or filaments, which consists in vaporizing tungsten by an electric discharge *in vacuo*, and depositing the same on a revolving surface in the path of the discharge, substantially as set forth.

3. The process of forming a film for an incandescent lamp filament or filaments, which consists in vaporizing a difficultly fusible metal by an electric discharge *in*

vacuo, depositing the same on a surface in the path of the discharge, and separating the film thus formed from the surface, substantially as set forth.

4. The process of forming a film for an incandescent lamp filament or filaments, which consists in vaporizing a difficultly fusible metal by an electric discharge *in vacuo*, depositing the same on a revolving surface in the path of the discharge, and separating the film thus formed from the surface, substantially as set forth.

5. The process of forming a film for an incandescent lamp filament or filaments, which consists in vaporizing tungsten by an electric discharge *in vacuo*, depositing the same on a surface in the path of the discharge, and separating the film thus formed from the surface, substantially as set forth.

6. The process of forming a film for an incandescent lamp filament or filaments, which consists in vaporizing tungsten by an electric discharge *in vacuo*, depositing the same on a revolving surface in the path of the discharge, and separating the film thus formed from the surface, substantially as set forth.

7. The process of forming a film for an incandescent lamp filament or filaments, which consists in forming electrodes by subjecting a difficultly fusible metallic powder to compression sufficient to effect cohesion of the particles, vaporizing the metallic powder by an electric glow discharge between the electrodes, depositing the metal in a thin film on a receiving surface in the path of the discharge, and separating the film thus formed from the surface, substantially as set forth.

8. The process of forming a film for an incandescent lamp filament or filaments, which consists in forming electrodes by subjecting substantially pure metallic tungsten to compression sufficient to effect cohesion of the particles, vaporizing the tungsten by an electric glow discharge between the electrodes, and depositing the same in a thin film on a receiving surface in the path of the discharge, substantially as set forth.

9. The process of forming filaments for incandescent lamps, which consists in vaporizing a difficultly fusible metal by an electric discharge *in vacuo*, depositing the same in a thin homogeneous film on a receiving surface in the path of the discharge, separating the film from the surface, cutting the film into strips of suitable width, rolling the strips over cores to form hollow tubes, and removing the cores, substantially as set forth.

10. The process of forming a filament for incandescent lamps, which consists in form-

ing a thin homogeneous film of a difficultly fusible metal by high tension electric deposition *in vacuo*, rolling the proper width of the film over a suitable core to form a
5 hollow tube of minute cross-sectional area, and bending the same into the form of a filament, substantially as set forth.

11. An electric lamp filament formed of a thin, homogeneous, coherent film of pure

tungsten deposited from a vaporized condition, substantially as described. 10

This specification signed and witnessed this 28th day of May 1907.

THOS. A. EDISON.

Witnesses:

FRANK L. DYER,
ANNA R. KLEHM.